REMARKS

This Response is being provided in response to the outstanding office action for this case dated October 27, 2000.

The rejection of claim 21, 2-4, 7-8, 12, 18-19 under 35 U.S.C. §103(a) as being unpatentable over Shimbo et al. (U.S. Patent No. 4,738,935) in view of Lee et al. (U.S. Patent No. 4,900,372) and Narayan et al. (U.S. Patent No. 5,208,182) is hereby traversed and reconsideration thereof is respectfully requested in view of the following remarks.

Independent claim 21 is directed to a method for forming low defect density epitaxial layers on lattice-mismatched substrates. The method includes the steps of (a) bonding a first substrate layer having a first lattice constant and a first thermal expansion coefficient to a second substrate layer having a second lattice constant and a second thermal expansion coefficient, thereby forming a composite substrate having a composite lattice constant and a composite thermal expansion coefficient; (b) disposing a buffer layer on the composite substrate, the buffer layer having a buffer layer lattice constant and a buffer layer thermal expansion coefficient; and (c) disposing a first epilayer on the buffer layer, the first epilayer having a first epilayer lattice constant and a first epilayer thermal expansion coefficient.

The second lattice constant and second thermal expansion coefficient of the second substrate layer is selected so that if the first epilayer lattice constant is greater than the composite lattice constant, then the first epilayer thermal expansion coefficient is smaller than the composite thermal expansion coefficient; and if the first epilayer lattice constant is smaller than the composite lattice constant, then the first epilayer thermal expansion coefficient is greater than the composite thermal expansion coefficient.

The buffer layer lattice constant is selected to be substantially identical to the epilayer lattice constant and the buffer layer thermal expansion coefficient is selected so that if the buffer layer lattice constant is greater than the composite lattice constant, then the buffer layer thermal expansion coefficient is greater than the composite thermal expansion coefficient, and if the buffer layer lattice constant is smaller than the composite

lattice constant, then the buffer layer thermal expansion coefficient is smaller than the composite thermal expansion coefficient.

The Shimbo reference ('935) discloses a method of manufacturing a compound semiconductor device wherein two compound semiconductor substrates having given impurity concentrations and thicknesses are bonded, thereby forming a junction with good electrical characteristics, irrespective of lattice constant mismatch therebetween. Shimbo mentions only the difference in the thermal expansion coefficient between the first and second substrate (col. 3, lines 23-29). This difference is not part of the subject matter recited in claim 21 of the present application. Accordingly, unlike the subject matter disclosed in the present invention, Shimbo does not disclose, teach or suggest a relationship between, on one hand, the composite thermal expansion coefficient of a composite substrate formed from the two compound semiconductor substrates and the composite lattice constant and, on the other hand, a lattice constant of a buffer layer and a first epitaxial layer, as recited in claim 21.

The Examiner asserts that the Lee ('372) and the Narayan ('182) references in combination provide the claimed subject matter missing from the Shimbo reference. Applicants respectfully disagree.

The Lee reference ('372) discloses a method for producing wafers having deposited layers of III-V materials on Si or Ge/Si or other single crystal substrates. Lee discloses various annealing methods to minimize the defects and balance the stresses. However, Lee does not teach or suggest selecting the buffer layer and the epitaxial layer based on the relationship between lattice constants and thermal expansion coefficient. The only example given by Lee is the growth of a GaAs epilayer on a GaAs buffer layer disposed on a Si/Ge substrate. These semiconductor materials have the following physical parameters:

Material	Lattice constant	Thermal expansion coefficient
Ge	5.646 Å	5.8×10^{-6} /°C
Si	5.431 Å	2.6×10^{-6} /°C
GaAs	5.653 Å	6.9×10^{-6} /°C

With the above parameters, the example given by Lee does not satisfy the criteria for the first epitaxial layer recited in claim 21, namely that if the first epilayer lattice constant is greater than the composite lattice constant, then the first epilayer thermal expansion coefficient is smaller than the composite thermal expansion coefficient. Lee does not provide additional examples, nor does he suggest selecting other materials according to the subject matter recited in claim 21. Accordingly, Shimbo in combination with Lee do not teach or suggest the subject matter of the present invention as recited in claim 21.

The Narayan reference ('182) discloses a method of forming a gallium arsenide on silicon heterostructure which includes the use of strained layer superlattices in combination with rapid thermal annealing to achieve a reduced threading dislocation density in the epilayers. For sake of argument, let's assume that Narayan's Si layer 10 and GaAs layer 12 is equivalent to the composite substrate of the present invention. This composite substrate would then have a lattice constant between 5,43 Å and 5.65 Å, and a thermal expansion coefficient between 2.6×10^{-6} /°C and 6.9×10^{-6} /°C. Let's further assume that GaAs layer 28 is equivalent to the first epilayer of the present invention. Like in Lee discussed above, since the lattice constant of Narayan's epilayer 28 is <u>greater than</u> the lattice constant of the composite substrate 10/12 while the thermal expansion coefficient of layer 28 is <u>also grater than</u> the thermal expansion coefficient of the composite substrate 10/12, Narayan does not disclose the criteria for the first epitaxial layer recited in claim 21, namely that if the first epilayer lattice constant is greater than the composite lattice constant, then the first epilayer thermal expansion coefficient is

smaller than the composite thermal expansion coefficient. Moreover, Narayan does not provide additional examples, nor does he suggest selecting other materials according to the subject matter recited in claim 21. Accordingly, Narayan in combination with Shimbo and Lee do not teach or suggest the subject matter of the present invention, as recited in claim 21.

In summary, none of the references of record, either alone or in combination, teach or suggest the particular relationships between lattice constants and thermal expansion coefficients recited in independent claim 21. The present invention is not merely a recognition of the fact that these parameters have to be optimized, but presents a novel method for optimizing growth parameters that is not disclosed in the prior art. Accordingly and contrary to the Examiner's assertion, these relationships are not obtainable by routine experimentation.

Accordingly, Applicants respectfully submit that the subject matter disclosed in the present invention is non-obvious over the prior art of record and request that the rejection of claim 21 be withdrawn. Claims 2-11 and 18 and 19 should be patentable for the same reason that claim 21 is patentable.

Based on the above Remarks, Applicants respectfully request that the Examiner reconsider and withdraw all outstanding rejections and objections. Favorable consideration and allowance are earnestly solicited. Should there be any questions after reviewing this paper, the Examiner is invited to contact the undersigned at 617-832-1000 (direct dial: 617-832-1753).

Respectfully submitted,

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